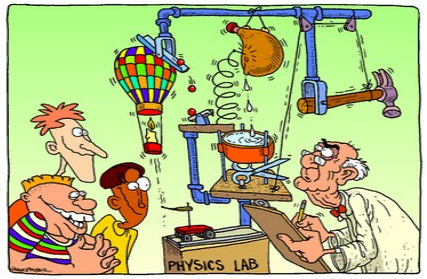
PHYSICS 105 - Principles of Physics

Kinematics 1D, Forces&vectors, kinematics 2D, Newton's law
Conservation momentum & collision, Energy & work
Optional: rotational kinematics
Math review: proportion, Sci. Notations, trig., vectors

LAB lasts 2:15
Don't expect less !



labs=30% ; tests (2) =25% ;quizzes/assignments=20% ; final=25%
See dates in the syllabus

Participation bumps final grade 1 up
Low Attendance = 1 or 2 grade down
Missing lab = 10 points down from lab grade
Texting, facebooking, sleeping... = 1 grade down
Strong positive correlation between assignments and tests
So do your HW even if I don't collect them.

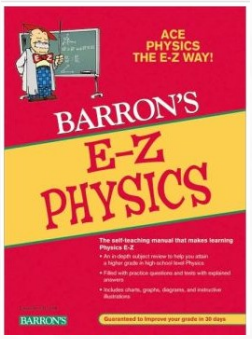
If it bites or scratches,
it's biology.
If it stinks or pops,
its chemistry.
If it doesn't work,
it's physics

LABS: BRING LAPTOP with spreadsheet
The labs will be in the shared folder.
Print it out or download it in your laptop.

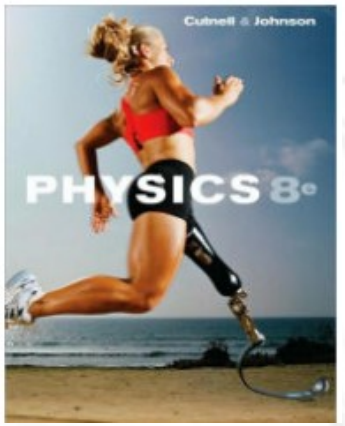
You can bring laptop in class with downloaded unit
The units are in the shared folder with all materials
Including labs

E-Z Physics (Barron's E-Z Series)
Paperback
by Robert L. Lehrman
ISBN 9780764141263

textbook



Other textbooks to consider (was used to build this class):
Physics / Edition 8 (more in depth)
by John D. Cutnell, Kenneth W. Johnson, Cutnell

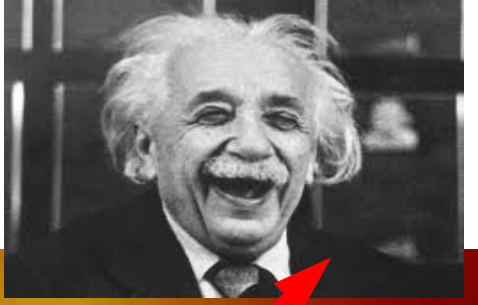


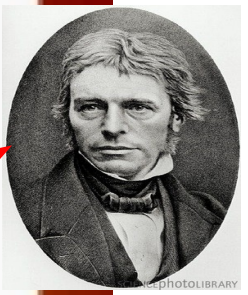
Conceptual Physics by Paul Hewitt (more conceptual but a master piece)

Physics of Everyday Phenomena 7th edition (to get started with Physics)
by Griffith, W. Thomas; Brosing, Juliet published by McGraw-Hill

Inquiry into Physics
Vern J. Ostdiek, Donald J. Born

Physics: describes the laws of nature/Universe





Michael Faraday

James Prescott Joule

Thomas Young

Demo : Law of induction.

Richard Feynman

https://www.youtube.com/watch?v=WqvImbn9GG4&list=PL860B6886A47E5490
demo by MIT

UNITS we will cover in this class:

- review Math :Proportions, scientific notation, trigonometry.

- Notions of motion – 1D kinematics, graphical analysis of motion free-fall.

- Vectors, components of vectors, adding vectors.

- Forces, equilibrium, torques.

- Kinematics 2D, projectile motion, circular motion.

- Newton's laws, impulse, momentum.

- Conservation of momentum, collision.

- Work and energy, conservation of energy, energy of spin.

If time permits: rotational kinematics

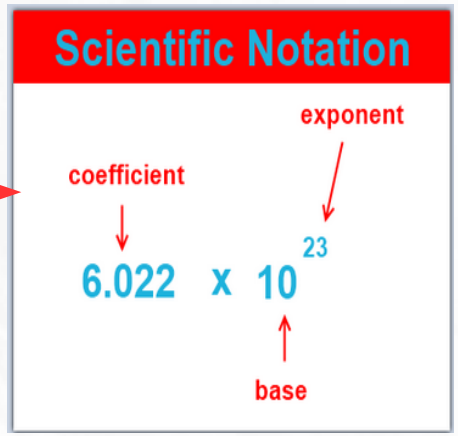
MATH REVIEW

- Solving proportion

See assignment_conversion_units in class

- scientific notation

See assignment_sci_not in class



- Read chapter 1 from your book
E-Z Physics (Barron's E-Z Series)

And do assignment_chapter1 as take home quiz

- trigonometry: will be covered in lab 3

Physics experiments involve the measurement of a variety of physical quantities.

These measurements should be accurate and reproducible.

The first step in ensuring accuracy and reproducible is defining the units in which the measurements are made.

Units and derived units

SI Base Units

Base Quantity	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Important:
Speed is in m/s
and m/s is noted m s^{-1}

Acceleration is in m/s/s
And is also noted m s^{-2}

Distance (displacement) is in m

SI Derived Units

Derived Quantity	Name	Symbol	Equivalent SI units
Frequency	hertz	Hz	s^{-1}
Force	newton	N	$m \cdot kg \cdot s^{-2}$
Pressure	pascal	Pa	N/m^2
Energy	joule	J	N·m
Power	watt	W	J/s
Electric charge	coulomb	C	s·A
Electric potential	volt	V	W/A
Electric resistance	ohm	Ω	V/A
Celsius temperature	degree Celsius	°C	K*

Important:
Units can give away equations.
Force is kg m/s/s →
Find the equation for force

find the equation for power

find the equation for pressure

Find he equation for energy

Remember :

1km = 1,000m (10^3 meters)
1m = 100cm (10^2 centimeters)
1cm = 10mm (10 millimeters)
1mm = 1000 μm (10^3 micrometers)
1m=1000 mm (10^3 mm)
1m = 1,000,000 μm (10^6 μm)
note that: if 1m = 10^6 μm then 1μm = 10^{-6} m
1mm= 10^{-3} m 1cm = 10^{-2} m

1 mile = 1,609m
10 N= 2.2 pounds

1min = 60s
1hour = 60min = 3600s
1 day = 24 h = 24x3600 s =86,400s

1kg = 1000 g
1g=1,000mg

Following is a list of prefixes and their meanings that are often used in conjunction with SI units:

Multiple	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

1m/s = 2.2 mph

On Earth 1 kg is 2.2 pounds
Note: kg is a mass
Pounds measures a weight.

Unit 1: kinematics 1D

1. Average speed - slide12

2. displacement (change in position) vs distance - slide 15

3. velocity vs speed - slide19

4. acceleration - slide 20

5. kinematics equations – slide 35

6. graphical analysis of motion - slide 45

7. Free-fall – see unit 1B

Kinematics deals with the concepts that are needed to describe motion.

Dynamics deals with the effect that forces have on motion.

Together, kinematics and dynamics form the branch of physics known as ***Mechanics.***

Kinematics is the portion of mechanics that describes motion without any reference to ?

a) forces

b) accelerations

c) velocities

d) displacements

e) time

Distance - Average speed

Distance (d) measures " how far" . Unit is m.

time (t) is the time elapsed. Unit is second.

Average speed (s) is the distance traveled divided by the time required to cover the distance. Unit is m/s.

$$\text{Average speed} = \frac{\text{total distance}}{\text{elapsed time}}$$

SI units for speed: meters per second (m/s)

Example:
A NASCAR car travels at an average speed of 190 miles/hour.
A) How long would a 500 mile race take in hours?
B) Convert 190mph to m/s
(remember1m/s = 2.2 mph)
C) in 5 hours how many miles were covered ?
Convert to km

$$\text{Average speed} = \frac{\text{Distance}}{\text{Elapsed time}}$$

Examples

1) How far does a jogger run in 1.5 hours (convert 1st in s) if his average speed is 2.22 m/s? Convert to km
Convert to miles (1 mile = 1,609m)

2) If it takes you 45 seconds to run 340m, what is your average speed?

3) How long does it take a skier to travel 650m, going 18.5m/s ?

4) at 9:00AM you start on a walk. At 10:30AM you are 4.6 miles from Your starting point. what is your average speed in mph ?
Convert to m/s (Sorry units used in Physics are meters, Seconds, kilograms, joule ..) 1 mile = 1609m

5) What is the average speed of a runner who finishes the 1,500 meters race in 3 minutes 30 seconds ? In m/s

Your speedometer does not indicate averages; it tells you how fast you are going now. This is your instantaneous speed. If the instantaneous does not change, you are going at a constant speed. The constant value of the speed will be equal to your average speed for the whole trip.

In Physics displacement and distance are not the same physical quantities.

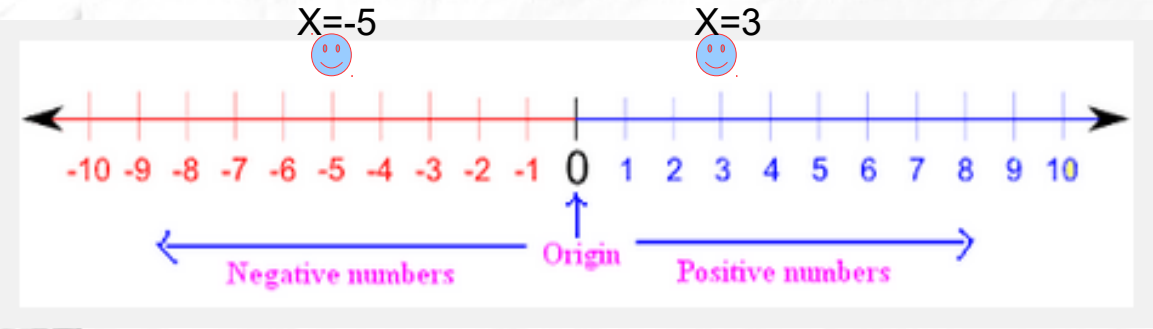
1) If you walk from A to B following the red path,
The distance d is the length of the path.
You can measure it using a surveyor wheel:

2) If you connect A (start) to B (end) using an arrow
This represent the displacement. $\overrightarrow{AB}$

A displacement has a length (length of arrow)
and a direction (like 30NW) .

In one dimension the displacement is just the change of position on the number line.
Displacement = final position – initial position

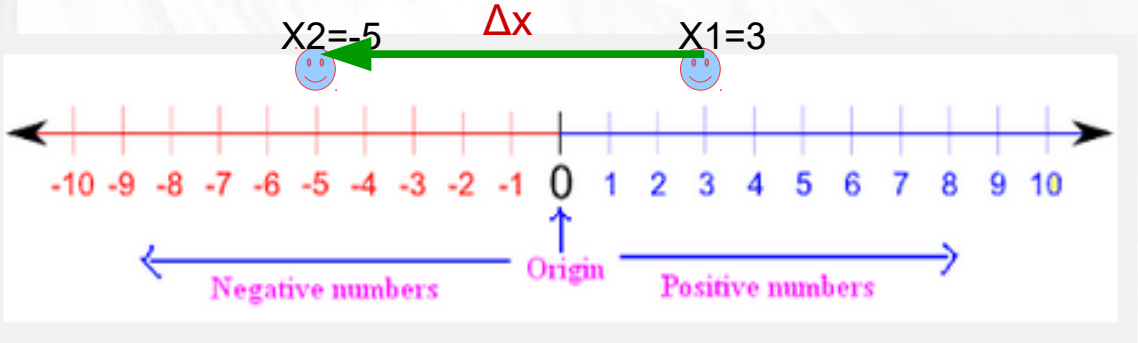
Position x: location on number line



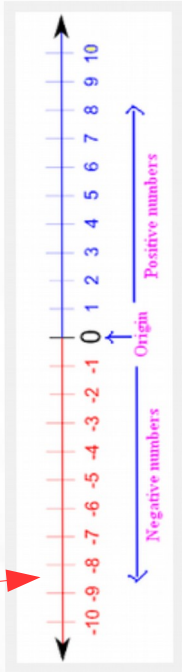
displacement Δx: change in position in 1D

Connect initial position to final position

$\Delta x = x_2 - x_1 = -5 - 3 = -8$ units

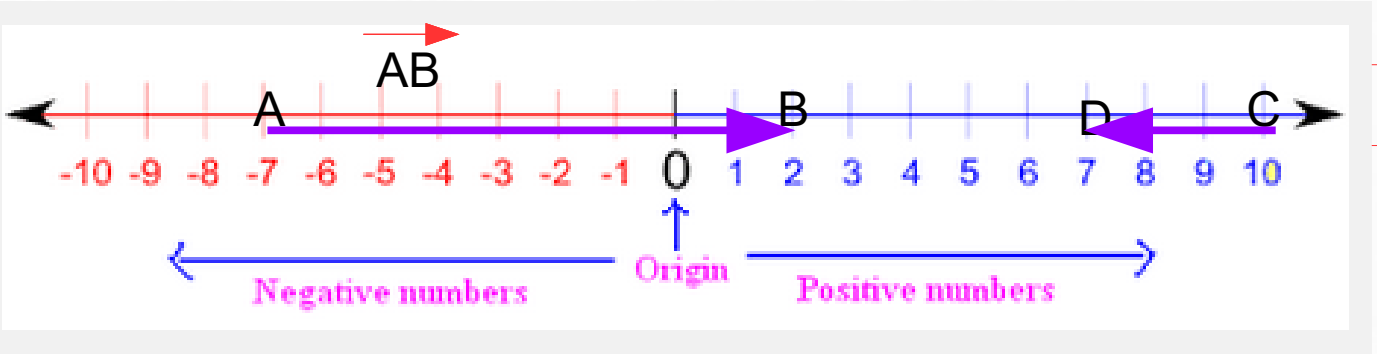


If Xinitial = -5 and displacement= 7 what is the final position Xfinal?



Same principle can apply to the vertical scale.
If Yinitial = -3 and the Yinitial= 2 what is the displacement

If the Yinitial is -10 and the displacement is 5 what is the final position yfinal?



$\vec{AB} = \Delta x = ?$

$\vec{CD} = \Delta x = ?$

If you move from A to B then B to A :
- what is the displacement ? (connect starting point to ending point or Xfinal-Xinitial)
- what is the distance ?

You can add displacements

+5 + 3 = +8

5 m

3 m

starting

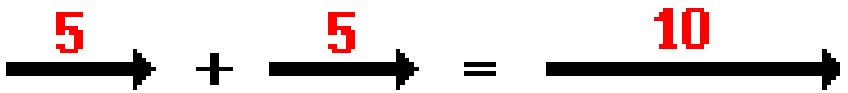
end

? m

Connect the starting point
To the final point

What is the sum of the displacements ?
What is the notation ?

A physical quantity that has a direction and a magnitude like a displacement is called a vector. It is represented by an arrow.

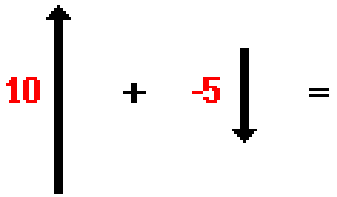


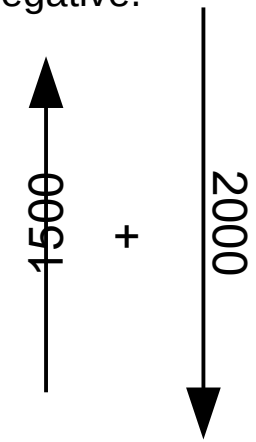
It is easy to add vectors in 1D. Complete the page.
Draw the vector sum and write its notation.

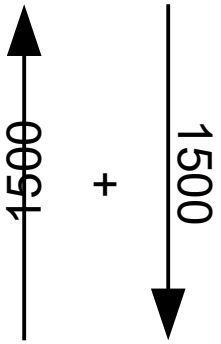
You walk 5 yards @ right and another 5 yards @ right .
The net sum is **10 yards @ right**

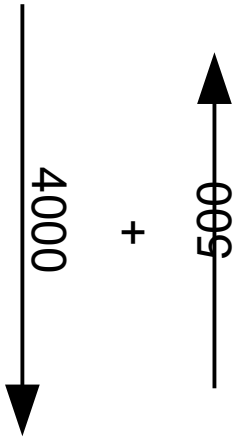
10 yards @ left is simply -10 yards.
Since there are only 2 directions. Minus is for left.

Up is positive
Down is negative.









Velocity is a vector –
If the object is moving @right, velocity is positive
If the object is moving @left, velocity is negative

average velocity = displacement / time : $V = \Delta x / time$

average speed= distance / time = d/t

1) A race car covers 1700m @ right in 5s. What is the average velocity?
The same race drive in the opposite direction with the wind opposing
Its motion. It covers 1700m @ left in 5.4 s. What is the average velocity ?

2) In NYC you walk 10 blocks @ south in 30minutes. What is your average velocity in:
Block/minute and block per hour

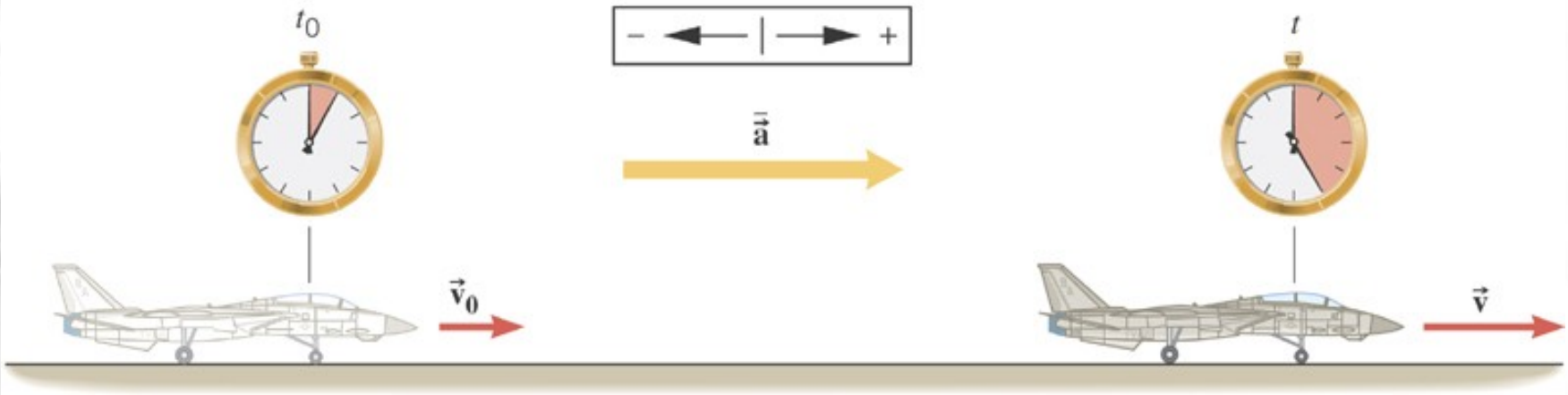
3) you drive 100 miles@east in 2 hours. What is your average velocity in mph and m/s

4) If you walk 5 blocks@ north and you realize this is the wrong way.
You then walk 10blocks @ south. The all trip lasted 30 minutes.
What is the average velocity (from start to end) in block/hour
What is the average speed. (not the same)

5) same question for 10 blocks @ west and 20 blocks @ east.
The trip lasts 1 hour.

6) same question for 100 miles @ North and 50 miles @ south in 2 hours.

7) An insect flies 5 inches@up 3 inches down then 15 inches @ up in 2 s.
What is its average velocity ?
Average speed?



DEFINITION OF AVERAGE ACCELERATION

(how fast an object is getting faster)

a =change of velocity / time elapsed = (Vfinal – Vfinal) / time

acceleration is the change of velocity per unit time

Unit is (m/s)/s or m/s/s or m/s^2

Example: acceleration due to gravity is about 22mph/s
Which means that every second a falling object goes 22mph faster every second.
A falling object (dropped from a tall tower) reaches a speed of 88mph after __ seconds.
The acceleration is @ down because the _____ of the object is pulling it down.

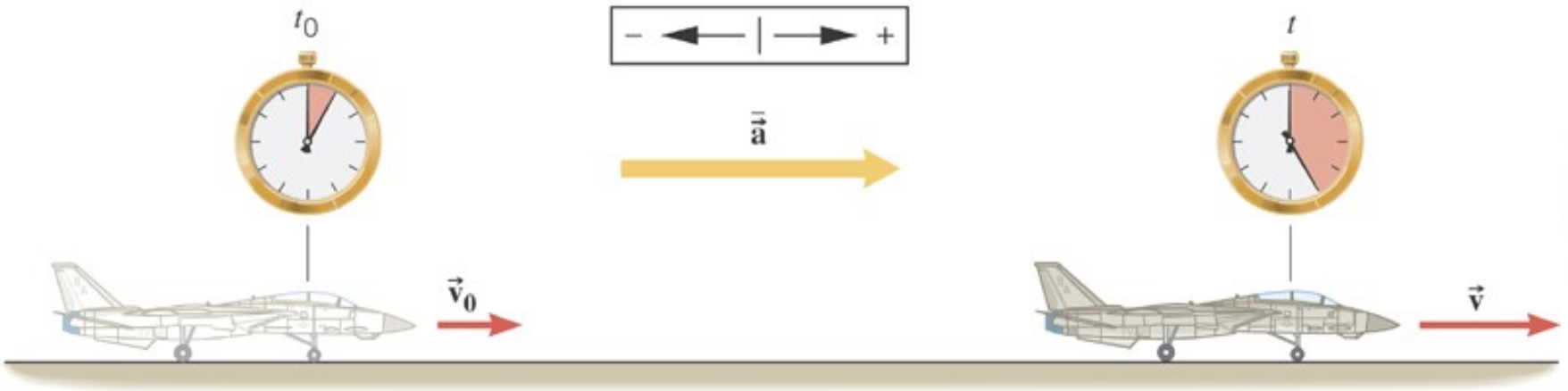
22mph per second is _____ m/s per second.
After 3 seconds of fall, the speed reached is _____ m/s

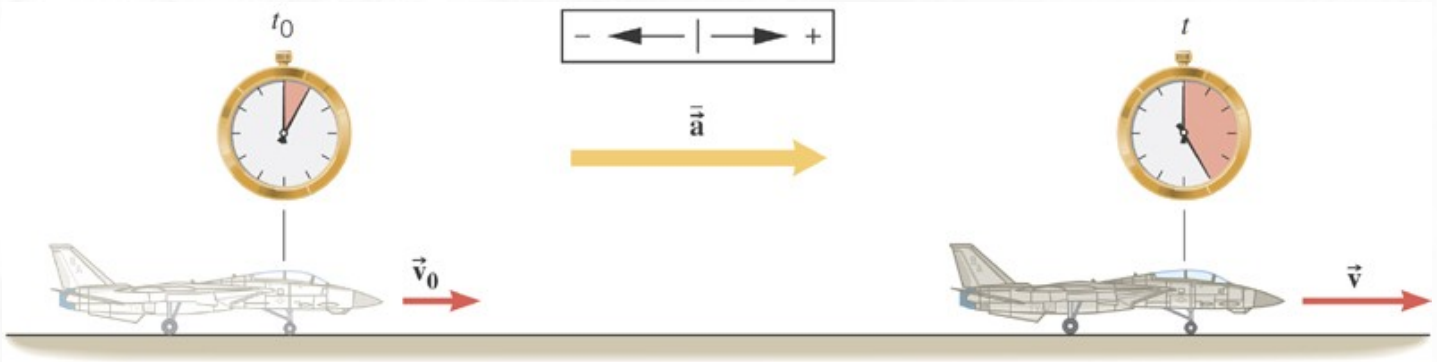
ACCELERATION is a vector.

It has a magnitude (change in velocity per unit time) and a direction

If there is a thrust (or push/pull) @ right, acceleration is positive
If there is a thrurst @ left, acceleration is negative.

The notion of *acceleration* emerges when a change in velocity is combined with the time during which the change occurs.





Example Acceleration and Increasing Velocity

Determine the average acceleration of the plane in km/h/s

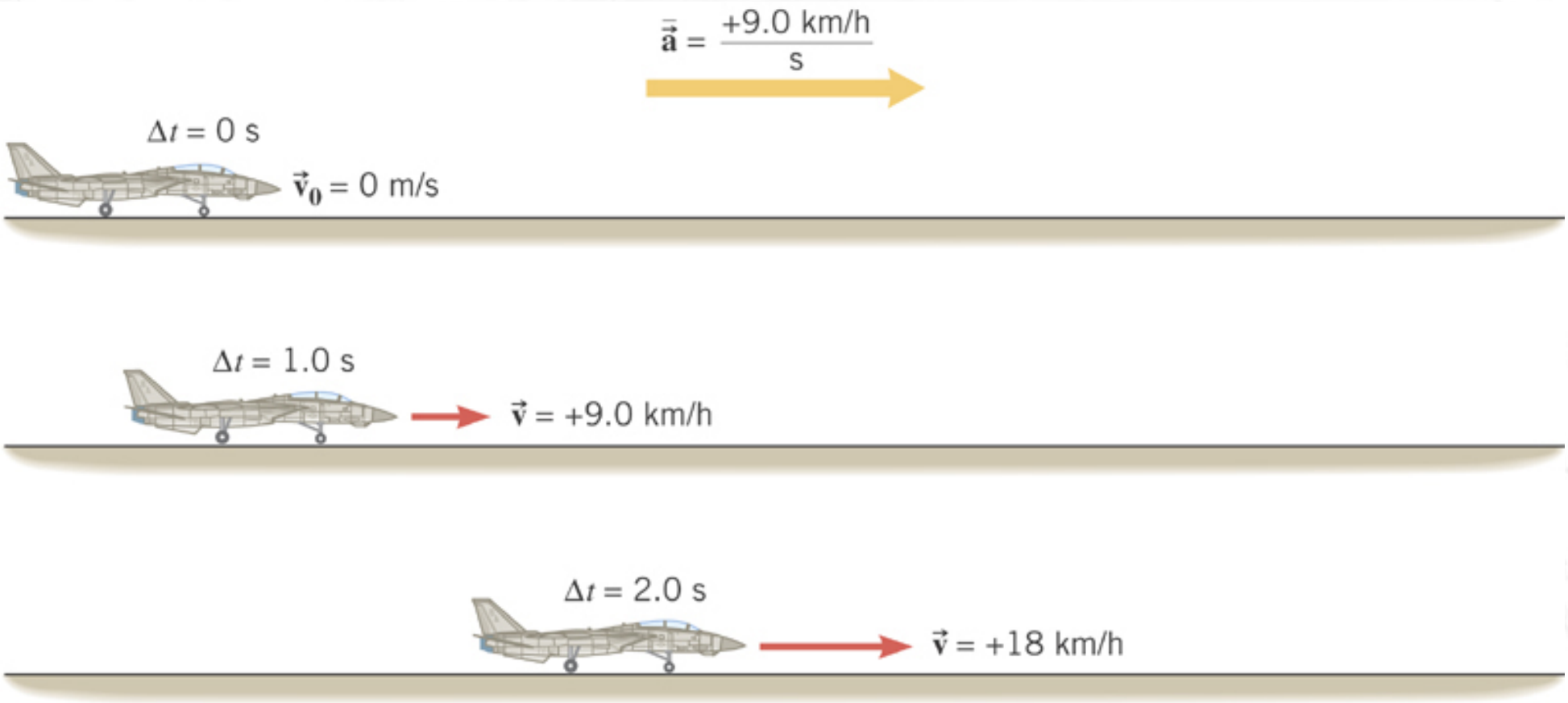
Vinitial = 0 Vfinal = 250km/h time elapsed=30s

A) Acceleration in km/h/s (see next slide before going to B)

B) How fast it is going after 5 seconds (find speed in km/h)

C) for the same acceleration what is the speed after 5s if the initial speed is 50km/h ?

D) convert the speed found in B to m/s (1km=1000m and 1 hour=3600s)



Acceleration is a vector:
9 is the magnitude ; km/h/s is the unit ; and + is the direction

Acceleration and Decreasing Velocity

Initial velocity = 28m/s
Final velocity = 13m/s
Between t=9s and t=12s

Find the acceleration

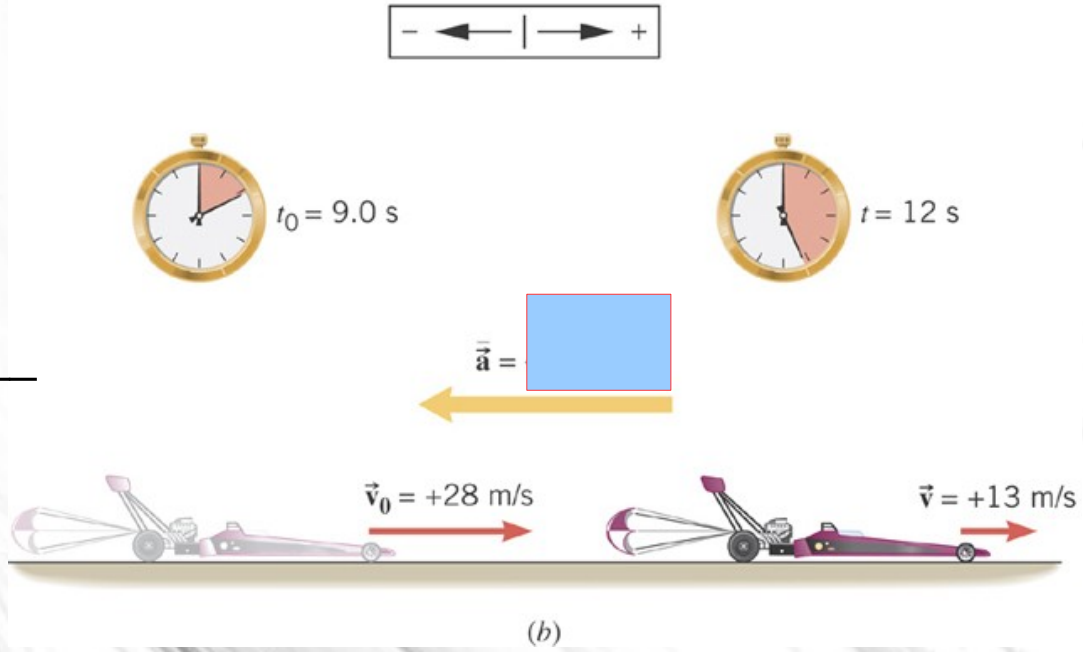
1. 5 m/s/s

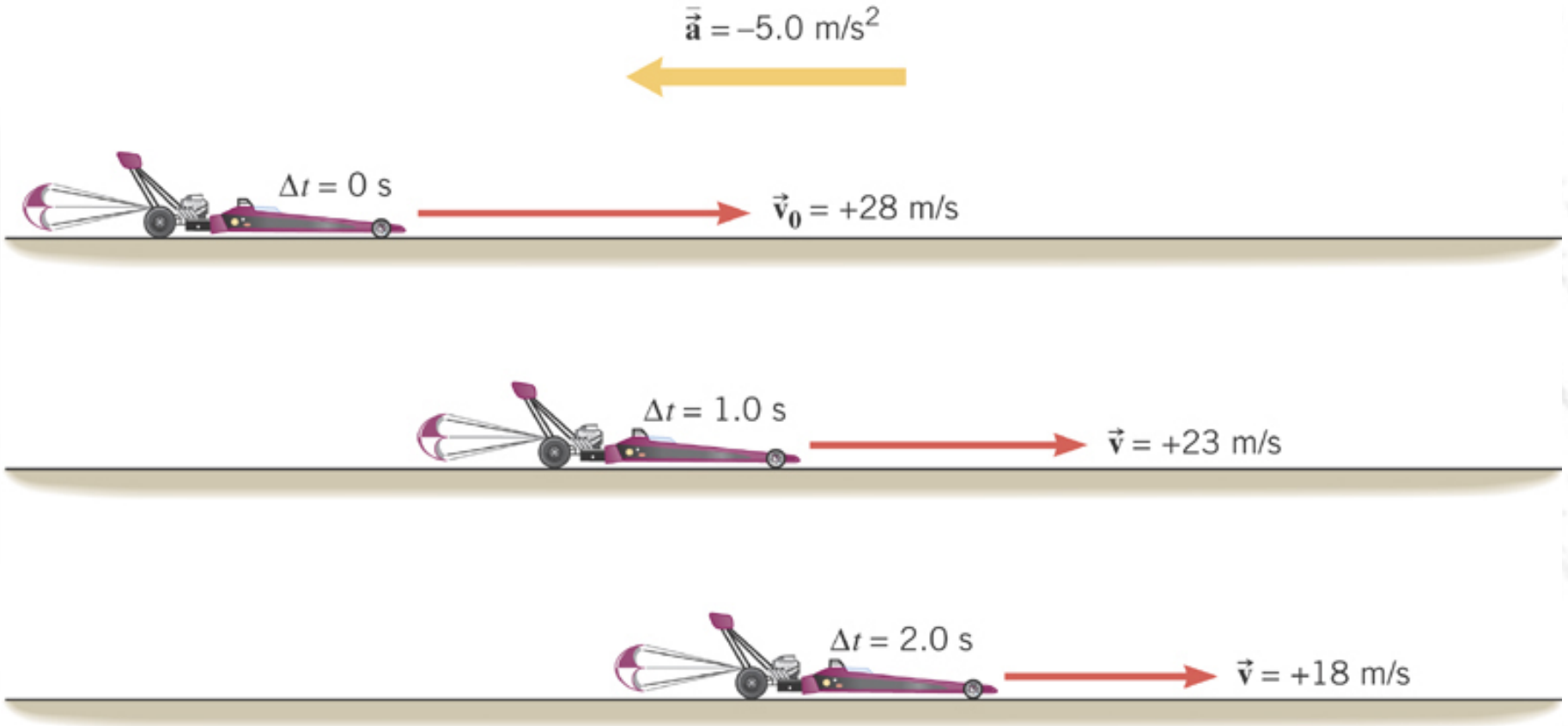
2. 1.7 m/s/s

3. - 5m/s/s

The acceleration has the same direction than the force (push/pull)
Here the pull is @ left so acceleration is @ __
but the velocity is @ _____

Velocity is a vector too. It has a _____
And a _____.





If velocity and acceleration have the same direction => speeding up
If velocity and acceleration have opposite direction => slowing down

http://www.walter-fendt.de/html5/phen/acceleration_en.htm

Use Vo=5 and a =1
Then Vo=10 and a = -1

http://phet.colorado.edu/en/simulation/moving-man

Initial position =-10
Initial Vo=5
Acceleration =-1

B)After watching the app above fill the table below.
Column 1 is the time elapsed Column 2 is the velocity

time	velocity	position
0		
3		
5		
7		
10		
12		
14		
16		

B) the position of an object moving with a constant acceleration is given by:
$X = X_{initial} + V_{initial} \times time + 0.5 \times a \times time^2$

C) Make 2 graphs. One graph for:
Velocity vs time
Position vs time

Starting from rest, a particle confined to move along a straight line is accelerated at a rate of 2 m/s^2.

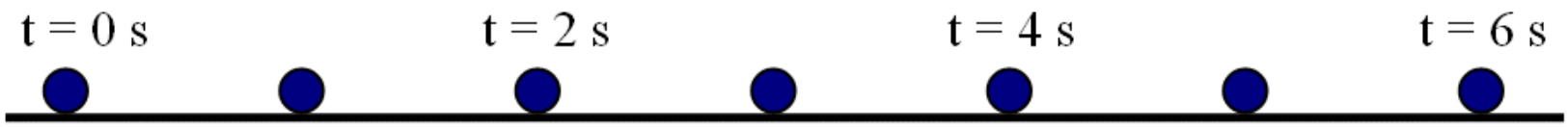
a) The particle travels 2 m during each second.

b) The particle travels 2 m only during the first second.

c) The speed of the particle increases by 2 m/s during each second.

d) The acceleration of the particle increases by 2 m/s^2 during each second.

The drawing shows the position of a rolling ball at one second intervals. Which one of the following phrases best describes the motion of this ball?



a) constant position

b) constant velocity

c) increasing velocity

d) constant acceleration

e) decreasing velocity

In which one of the following situations does the car have an acceleration that is directed due north?

a) A car travels northward with a constant speed of 24 m/s.

b) A car is traveling southward as its speed increases from 24 m/s to 33 m/s.

c) A car is traveling southward as its speed decreases from 24 m/s to 18 m/s.

d) A car is traveling northward as its speed decreases from 24 m/s to
18 m/s.

e) A car travels southward with a constant speed of 24 m/s.

A postal truck driver driving due east gently steps on her brake as she approaches an intersection to reduce the speed of the truck. What is the direction of the truck's acceleration, if any?

a) There is no acceleration in this situation.

b) due north

c) due east

d) due south

e) due west

A sports car starts from rest. After 10.0 s, the speed of the car is 25.0 m/s. What is the magnitude of the car's acceleration?

a) 2.50 m/s^2

b) 5.00 m/s^2

c) 10.0 m/s^2

d) 25.0 m/s^2

e) 250 m/s^2

Which one of the following is not a vector quantity?

a) acceleration

b) displacement

c) instantaneous velocity

d) average velocity

e) average speed

Which one of the following equations is the correct expression for average acceleration?

a) $a = \frac{v}{t}$

b) $a = \frac{dv}{dt}$

c) $a = \frac{\Delta x}{\Delta t}$

d) $a = \frac{\Delta v}{\Delta t}$

e) $a = \frac{1}{2} v t^2$

1) What is the acceleration of a rocket ship in outer space that takes 5.0s to increase its speed from 1240m/s to 1300m/s ?
(textbook)

2) In outer space a rocket ship is traveling at the enormous speed of 2800m/s. What is its acceleration if it increases its
Speed uniformly and is going 2840m/s after 25 s ?
Convert to mph (do it in class)

3) A car travels with an average speed of 25m/s (do it in class)
A) What is the speed in km/s
B) What is the speed in km/h

4) A car travels with an average speed of 58MPH. What is the speed in km/h (do it in class)

5) Starting from rest and moving in a straight line, a runner achieves a velocity of 7m/s in a time of 2s. What is the
Average acceleration of the runner ?

6) starting from rest, a car accelerates at a rate of 4.2m/s/s for a time of 5 seconds. What is its velocity at the end of this time ? (in class)

7) The velocity of a car decreases from 30m/s to 18m/s in a time of 4seconds. What is the average acceleration if the car
In this process ? (in class)

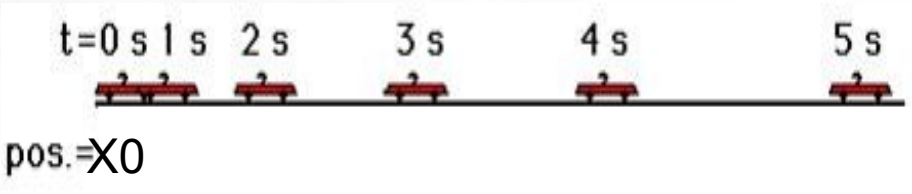
Equations of kinematics: the big 5

Notations:

V (Vfinal) final velocity
Vo (Vinitial) initial velocity → velocity at t=0
Xo (Xinitial) initial position → position at t =0
X (Xfinal) final position
Δx is the displacement (x-xo)
a acceleration
t is the time elapsed

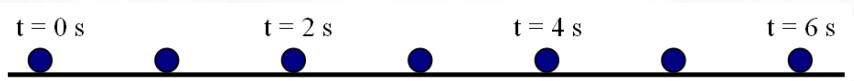
EQUATIONS OF KINEMATICS
for motion with constant acceleration

1) $x=xo+Vot+0.5\,a\,t^2$ or $\Delta x=Vot+0.5\,a\,t^2$ if xo=0 then $x=Vot+0.5\,a\,t^2$
2) V=Vo+ at
3) a =(V-Vo)/t
4) $V^2=Vo^2+2a(x-xo)$ or $V^2=Vo^2+2a(\Delta x)$
5) Average velocity=Δx/t or (V+Vo)/2



EQUATIONS OF KINEMATICS
for motion with velocity and acceleration = 0

1) x=xo +Vot or Δx=Vot if xo=0 then x=Vot
2) V=Vo stays the same
3) a =0
4) NA
5) Average velocity= Δx/t



Let's use the 2 equations : $x = xo+Vot+0.5\ (a)\ t^2$ and $V = Vo + at$

1) A car accelerating with an initial velocity of 12m/s accelerates at a constant rate of 2.5m/s/s for a time of 2s.
A) What is its velocity at the end of this time ?
B) What distance does the car cover during this process (the initial position Xo =0 find X)

2) A car moving with an initial velocity of 30m/s slows down at a constant rate of -3m/s/s
A) What is the velocity after 3 seconds of deceleration
B) What distance does the car cover in this time: (Find X with Xo=0)

3) A runner moving with an initial velocity of 9m/s slows down at a constant rate of -1.5m/s/s over a period of 2 seconds.
A) What is her velocity at the end of this time
B) What distance did she cover during this process(X with Xo=0)

4) Starting from rest (Vinitial =0) , a car accelerated at a constant rate of 3m/s/s for a time of 5 seconds. Xo=0
A) Compute the velocity of the car at 1s, 2s, 3s, 4s and 5s and plot the velocity versus time.,
B) What is the equation of this line ? (V as a function of time)
C) compute the distance (so X) traveled for these time and plot the distance against time

t	0	1	2	3	4	5
V						

t	0	1	2	3	4	5
X						

D) What is the equation of the position X vs time

5) if Vo=3m/s and Vfinal = 9m/s What is the average speed if the acceleration Is constant.

6) If the initial velocity of a car is 30m/s and its acceleration is 10m/s/s . Initial position is 0.
A) what its equation of motion x=f(t) .
B) what is the equation of V=f(t))velocity as a function of time)

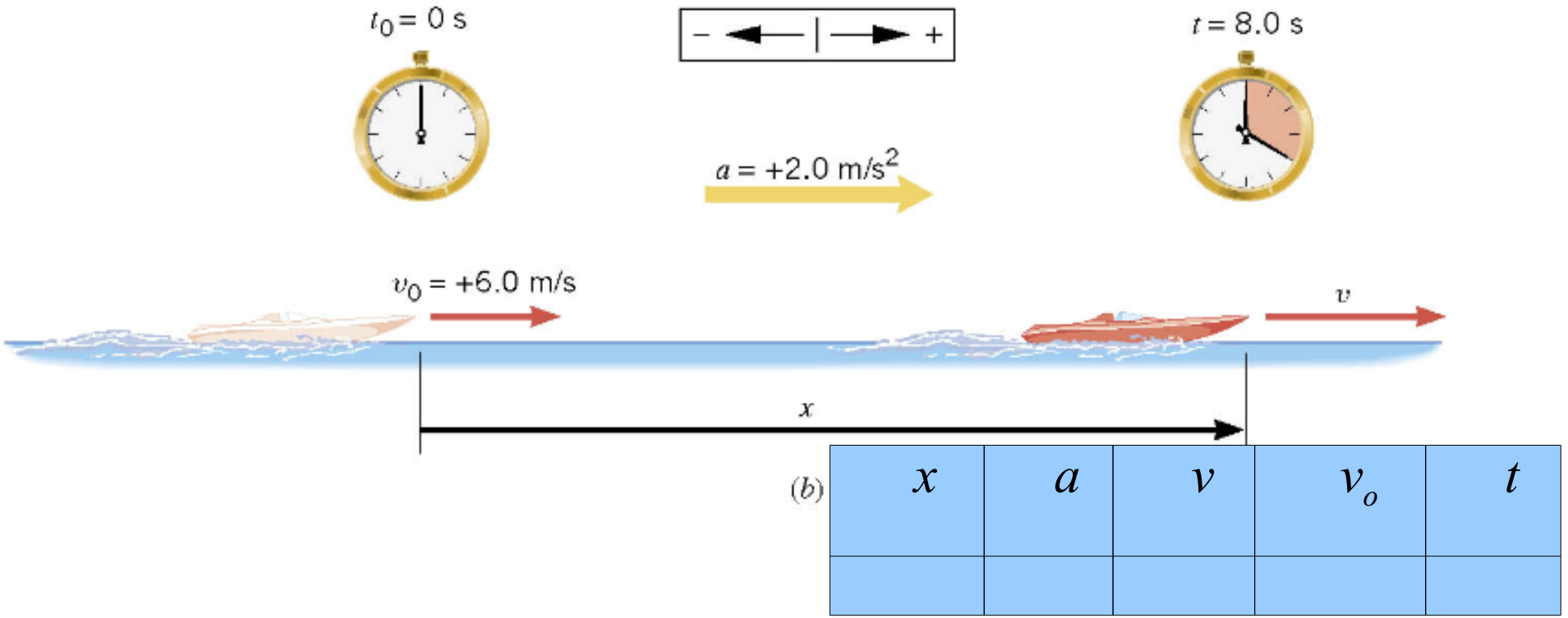
7) if the equation of motion of an object is $x = 5 + 10t + 2t^2$ What are:
Initial position ?initial velocity ? Acceleration ?

8) same question for $x = 10t + t^2$

9) $x = 10t^2$

10) if $x = 5 + 10t + 10t^2$
What is the velocity at t=5s (after 5s)

11) if V =10+2t
What is the acceleration ?
What is the final velocity when t=100s (so after 100s)?
What is the average speed during that time ?



FIND THE displacement of the boat :

1. 64m

2. 72m

3. 76m

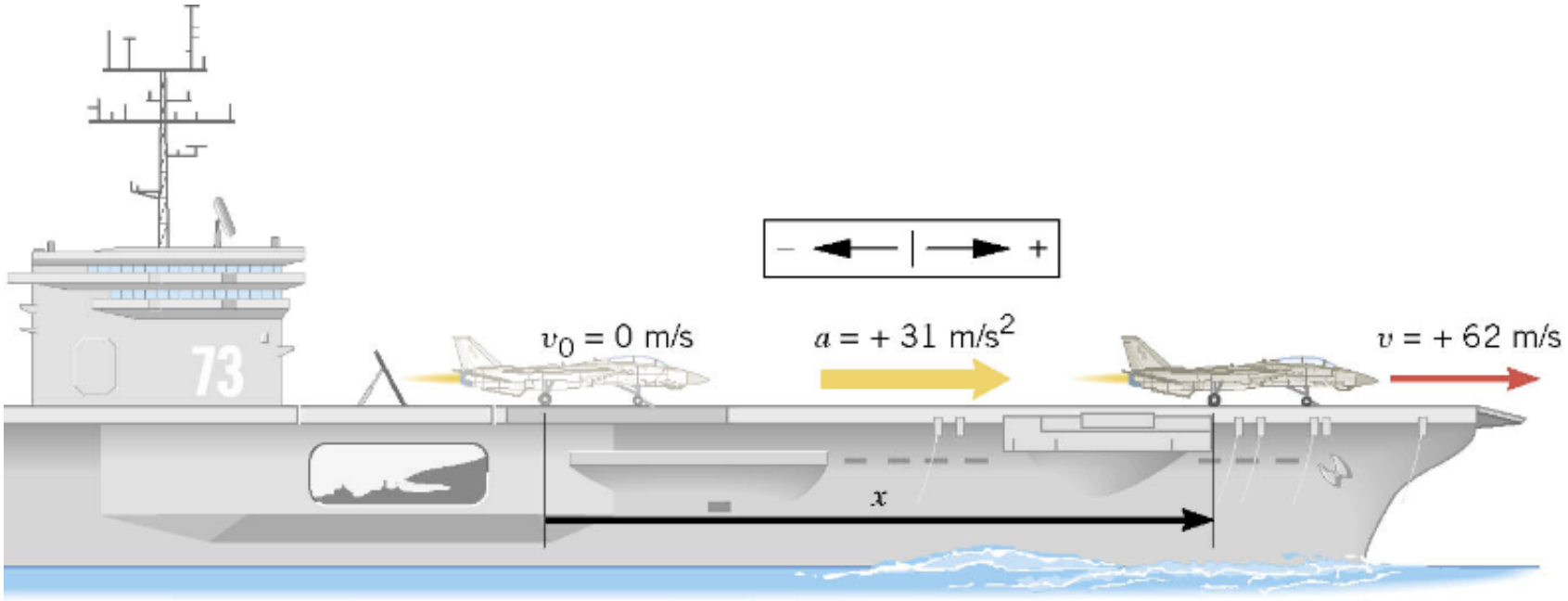
4.112m

[1] $x = v_0 t + \frac{1}{2} a t^2$

[2] $v = v_0 + a t$

[3] $a =$ constant

[4] $v^2 = v_0^2 + 2a(x)$



FIND THE displacement of the airplane :

1. 62m

2. 1m

3. 124m

x	a	v	v_o	t

[1] $x = v_0 t + \frac{1}{2} a t^2$

[2] $v = v_0 + a t$

[3] $a =$ constant

[4] $v^2 = v_0^2 + 2a(x)$

2.4.3. In which one of the following situations is the displacement of the ball directly proportional to the elapsed time?

a) a ball rolls with constant velocity

b) a ball at rest is given a constant acceleration

c) a ball rolling with velocity v0 is given a constant acceleration

d) a ball rolling uphill experiences a decreasing acceleration

e) a ball rolling downhill experiences an increasing acceleration

Example 8 An Accelerating Spacecraft

A spacecraft is traveling with a velocity of +3250 m/s. Suddenly the retrorockets are fired, and the spacecraft begins to slow down with an acceleration whose magnitude is 10.0 m/s^2. What is the velocity of the spacecraft when the displacement of the craft

- is +215 km, relative to the point where the retrorockets began firing?

x	a	v	v_o	t

2 possible answers.

1. +/- 6262500 m/s
2. +/- 2502.5 m/s
3. +/- 3855 m/s

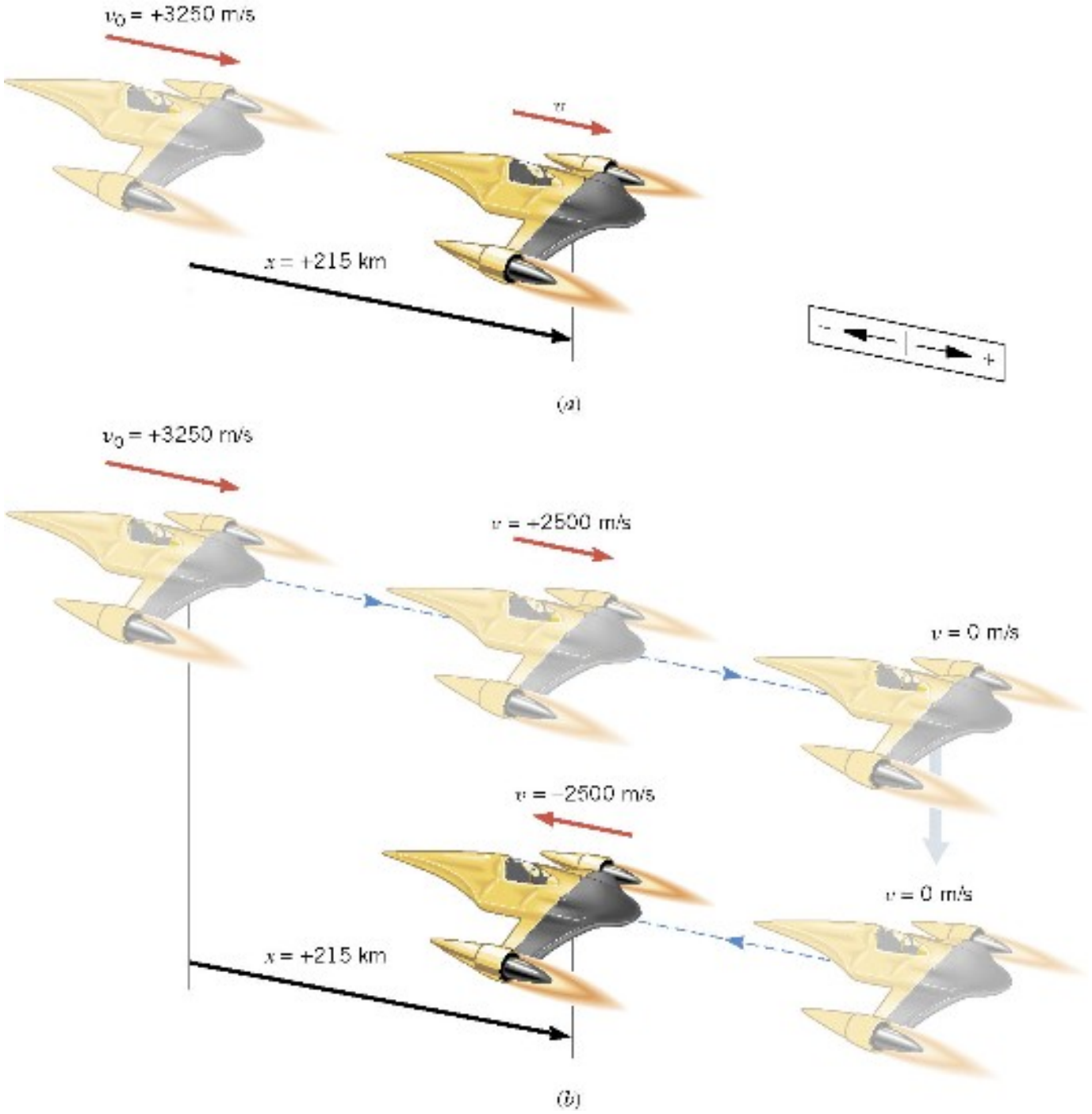
[1] $x = v_0 t + \frac{1}{2} a t^2$

[2] $v = v_0 + a t$

[3] $a =$ constant

[4] $v^2 = v_0^2 + 2a(x)$

Why 2 possible answers ?



1) How far does a car travel if it starts at rest and accelerated at 3m/s/s for **6.5s** (HW)
2) How long does it take a car, starting from rest, to travel 240m if its acceleration is 1.90m/s/s ? (in class)

3) How far a car travel if it starts at rest and accelerated at 3m/s/s until it reaches a speed of 22m/s ? (in class)

4) A car moving 22m/s has its brakes jammed on and leaves skid marks 45m long. What was its acceleration ?
(negative) (in class)

5) What is the acceleration of a rocket-driven sled that travels 360m in 5s, starting from rest and accelerating uniformly ? (HW)
HW
6) How fast is a car going it if starts at rest and accelerates uniformly at 2.8m/s/s while traveling 220m ? (HW)

7) A railroad engine moves forward along a straight section of track for a distance of 80m due west at a constant speed of 5m/s. It then reverses its direction and travels 20m due east at a constant speed of 4m/s. The time required for this Deceleration and reversal is very short due to the small speed involved.
A) What is the time required for the whole process ?
B) sketch a graph of position vs time for this process. Check the slopes.
C) sketch velocity versus time
Solution slide:91

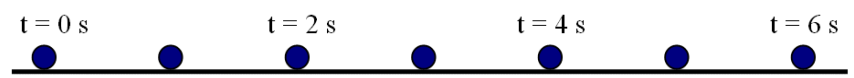
8) A car traveling in a straight line with an initial velocity of 14m/s accelerates at 2m/s/s to a velocity of 24m/s.
A) How much time does it take for the car to reach the velocity of 24m/s ?
B) What is the distance covered by the car in this process ?
(in class)

10) A runner moving at an initial velocity of 9m/s slows down at a constant rate of -1.5m/s/s over a period of 2 seconds.
A) What is her velocity at the end of this time ?
B) What distance does she travel during this process ?
(in class)

11) A car moving with an initial velocity of 30m/s slows down at a rate of – 3m/s/s.
A) What is the velocity after 3 seconds of deceleration
B) What distance does the car cover during that time?/
(HW)

GRAPHICAL ANALYSIS OF MOTION

EQUATIONS OF KINEMATICS
for motion with velocity and acceleration = 0



1) x=xo +Vot

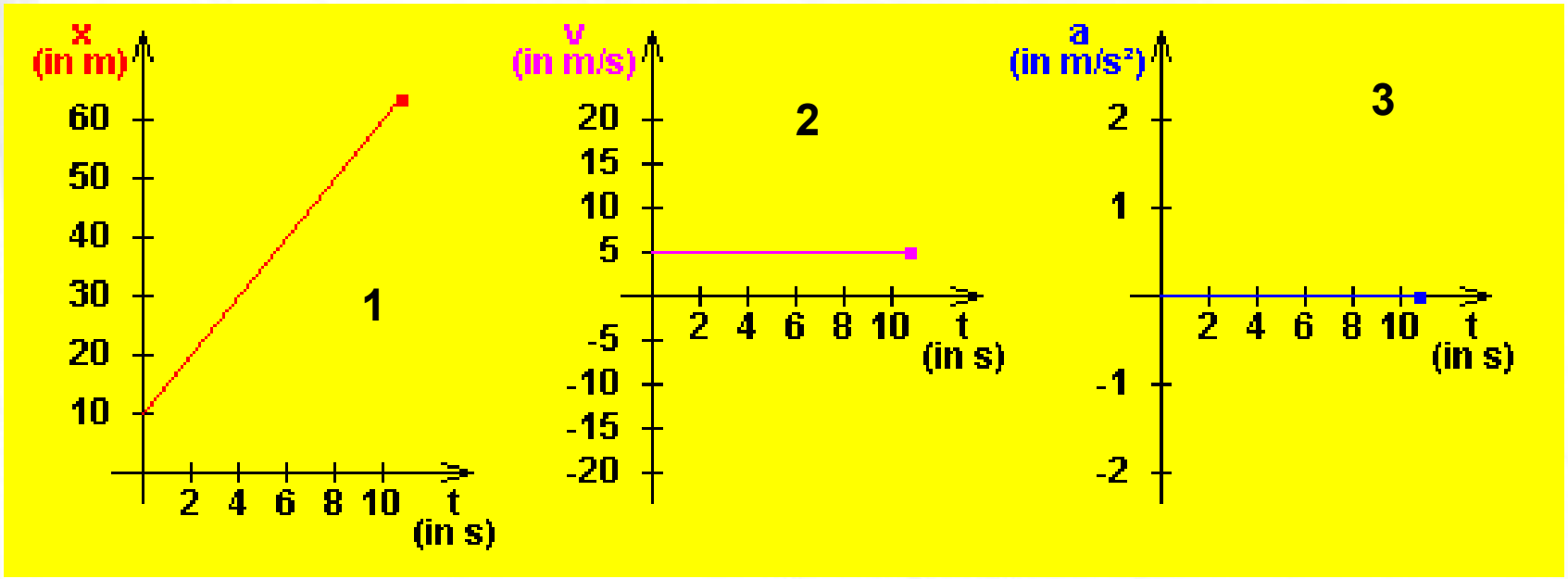
Position vs time x(t) is a straight lime. Vo is the slope. Xo the y-intercept

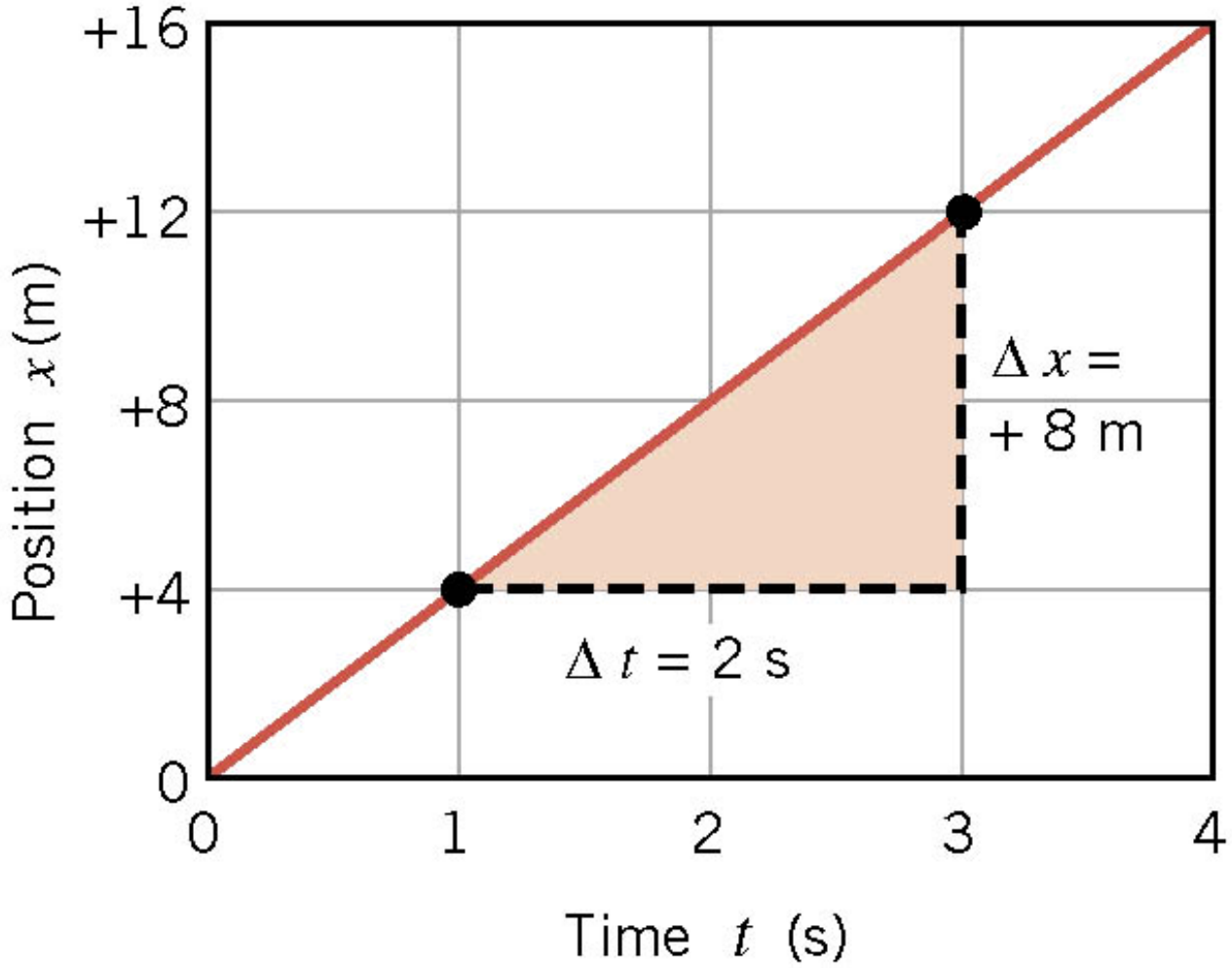
2) V=Vo stays the same

Velocity vs time V(t) = Vo is a horizontal line

3) a =0

Acceleration is 0



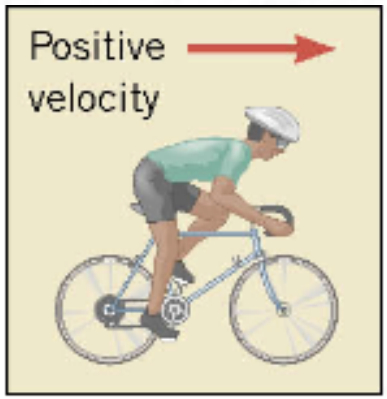


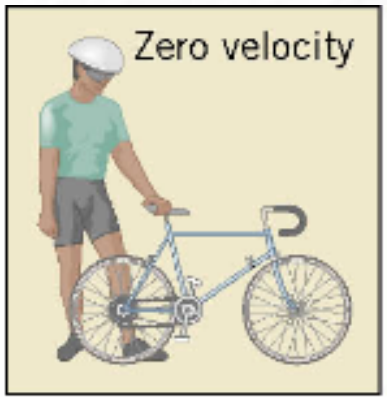
$$\text{Slope} = \frac{\Delta x}{\Delta t} = ?$$

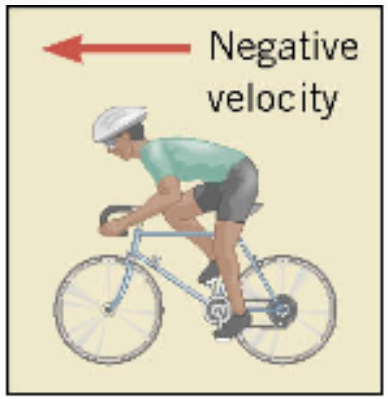
What does the slope of the graph position vs time represent?

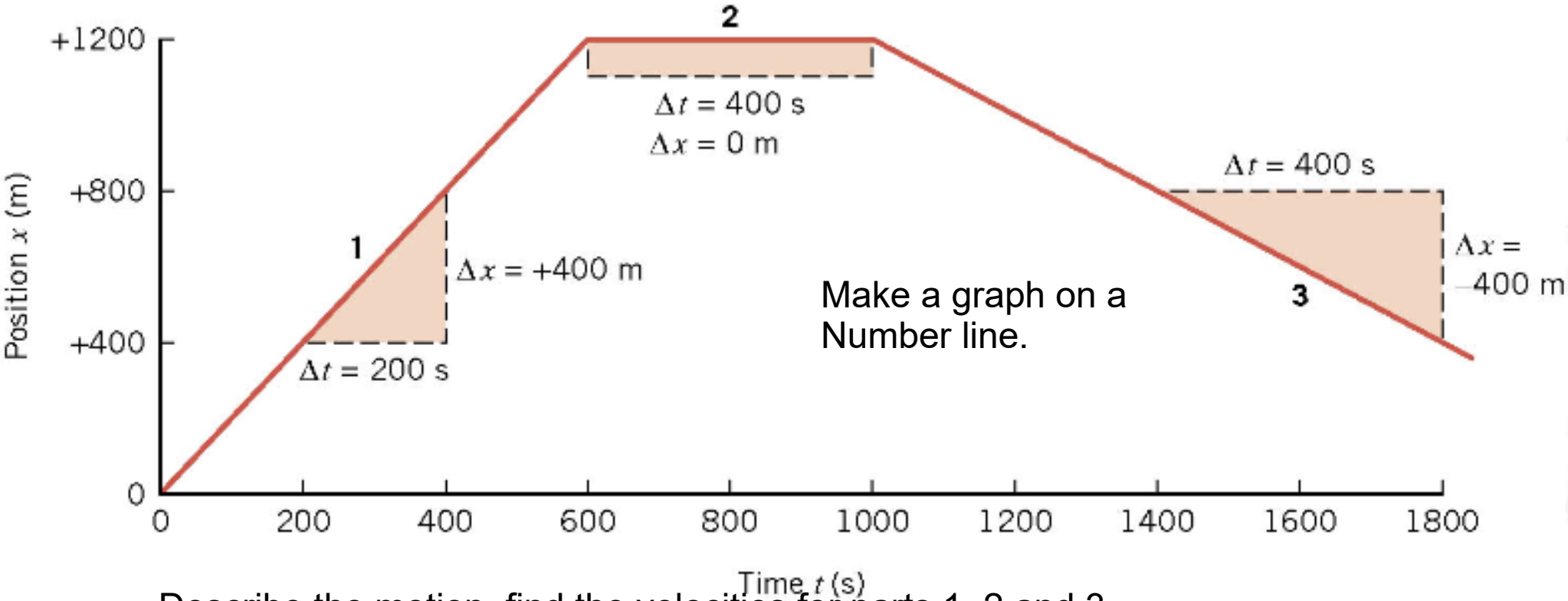
What is the unit ? What is the slope
What is the the equation of motion x(t)

2.7 Graphical Analysis of Velocity and Acceleration



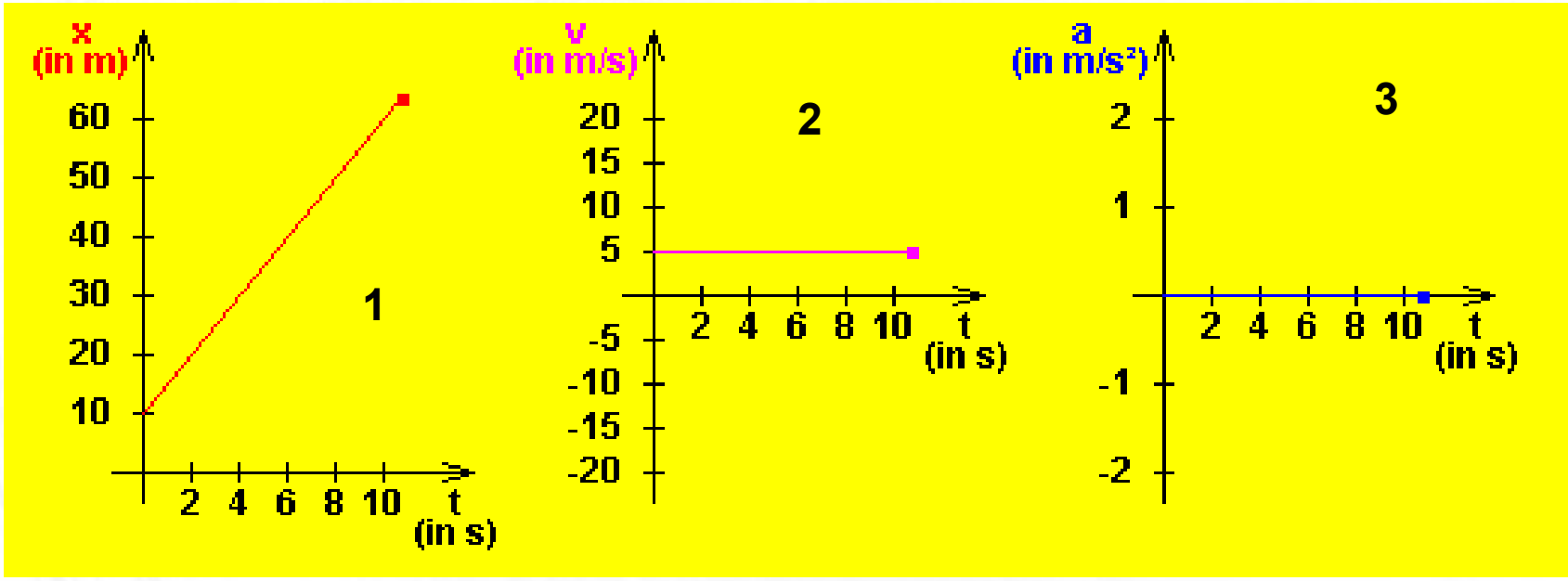






Make a graph on a Number line.

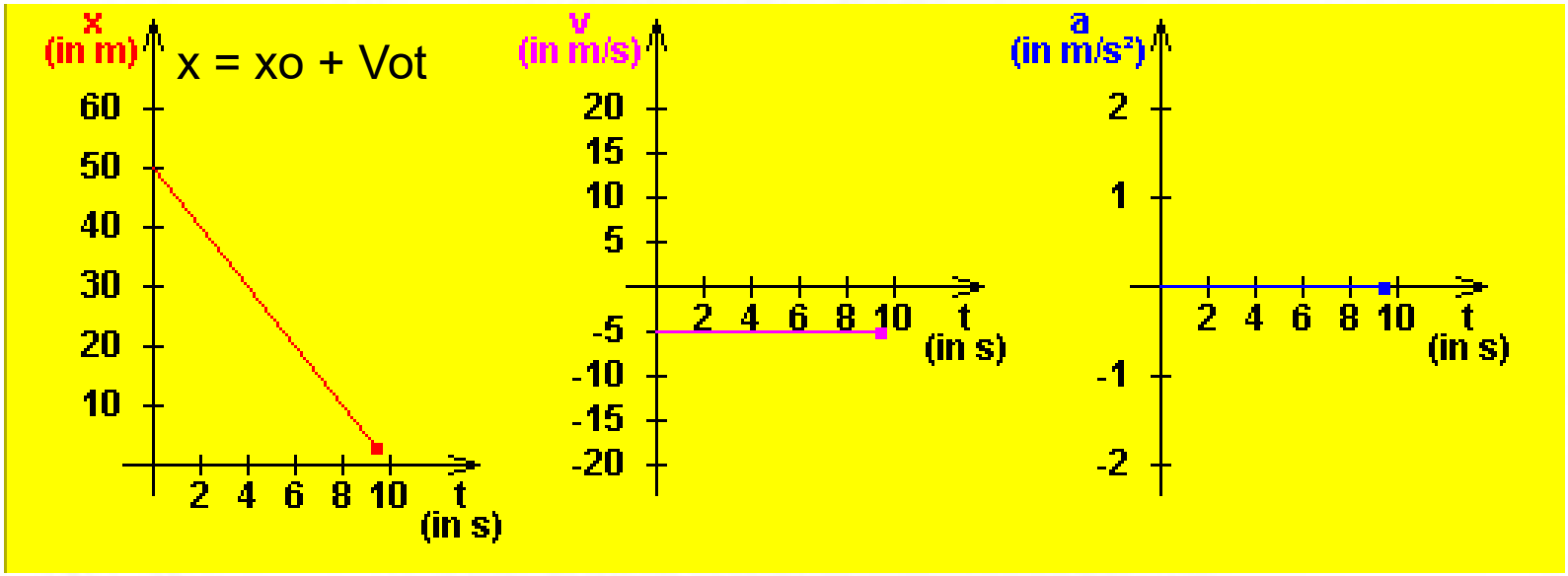
Describe the motion, find the velocities for parts 1, 2 and 3 , don't forget the directions.



A) from graph 3 what is the acceleration ?
B) from graph 2 what is the velocity ?
Why is the velocity negative (what do you think it means ?)
C) from graph 1 what is the initial position Xo ?
What is the slope ? What does the slope represents ?
What is the equation of motion x(t) ?
D) fill the table
E) from the table : the change of position per second:
Stays the same ? Increases ?
F) copy the table in a spreasheet. Make a scatter plot. Fit the best fit line.
Display equation. What is the equation ? So ?

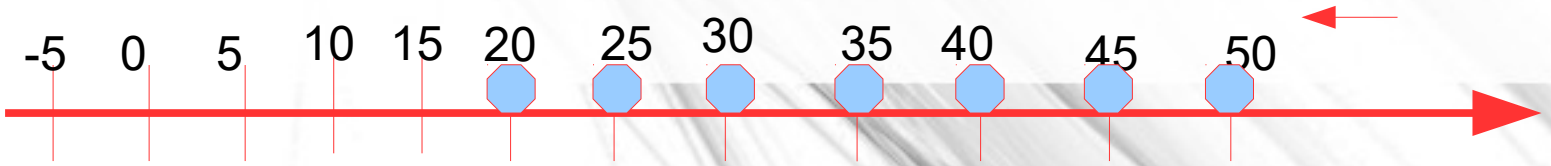
t	x
0	
1	
2	
3	
4	
5	

http://www.walter-fendt.de/ph14e/acceleration.htm



A) from graph 3 what is the acceleration ?
B) from graph 2 what is the velocity ?
Why is the velocity negative (what do you think it means ?)
C) from graph 1 what is the initial position Xo ?
What is the slope ? What does the slope represents ?
What is the equation of motion x(t) ?
D) fill the table
E) from the table : the change of position per second:
Stays the same ? Increases ?
F) copy the table in a spreasheet. Make a scatter plot. Fit the best fit line.
Display equation. What is the equation ? So ?

t	x
0	
1	
2	
3	
4	
5	



Complete the following statement: For an object moving at constant velocity, the distance traveled

a) increases for each second that the object moves.

b) is the same regardless of the time that the object moves.

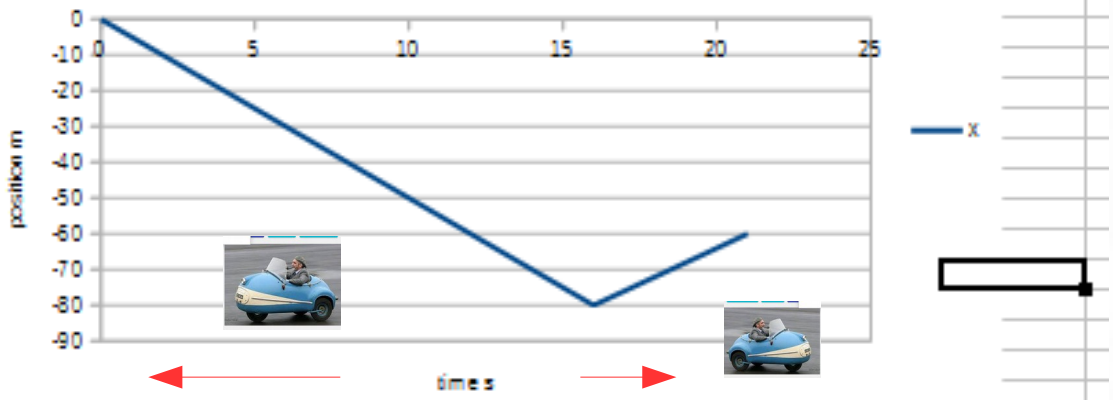
c) is the same for each second that the object moves.

d) cannot be determined, even if the elapsed time is known.

e) decreases for each second that the object moves.

Consider the motion of this car and the graph of its position vs time.
What is happening at t = 16s ?
Describe the direction of motion for each part.
What is the velocity during the first part of motion? (you can use table)
What is the velocity during the second part of the motion? (Use table)
What is the initial position of the car ?
What is the equation of motion for the first part of motion x(t)?

t	x
0	0
1	-5
2	-10
3	-15
4	-20
5	-25
6	-30
7	-35
8	-40
9	-45
10	-50
11	-55
12	-60
13	-65
14	-70
15	-75
16	-80
17	-76
18	-72
19	-68
20	-64
21	-60



Sketch the graph velocity vs time

http://www.walter-fendt.de/ph14e/acceleration.htm

EQUATIONS OF KINEMATICS
for motion with constant acceleration

1) $x = x_o + V_o t + 0.5\, a\, t^2$

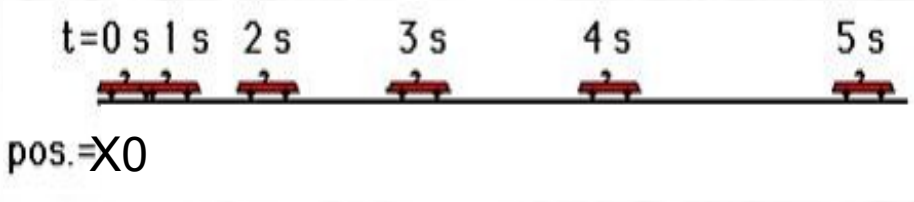
The graph x(t) or position vs time is a parabola. The y-intercept is Vo.
The slope increases = acceleration. The displacement increases every second.

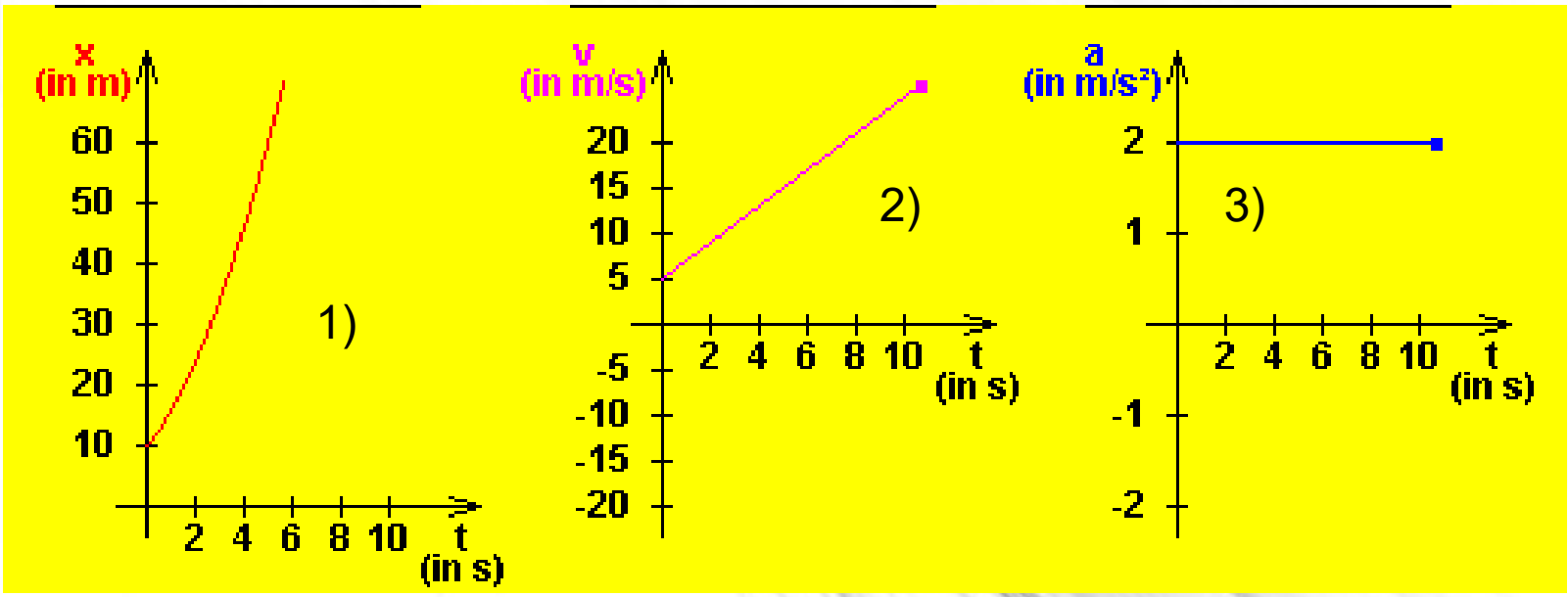
2) V = Vo + a t

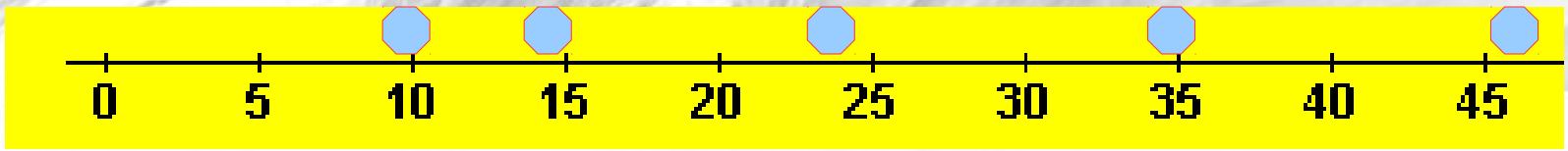
The graph is a line. The slope is the acceleration a. The y-intercept is Vo

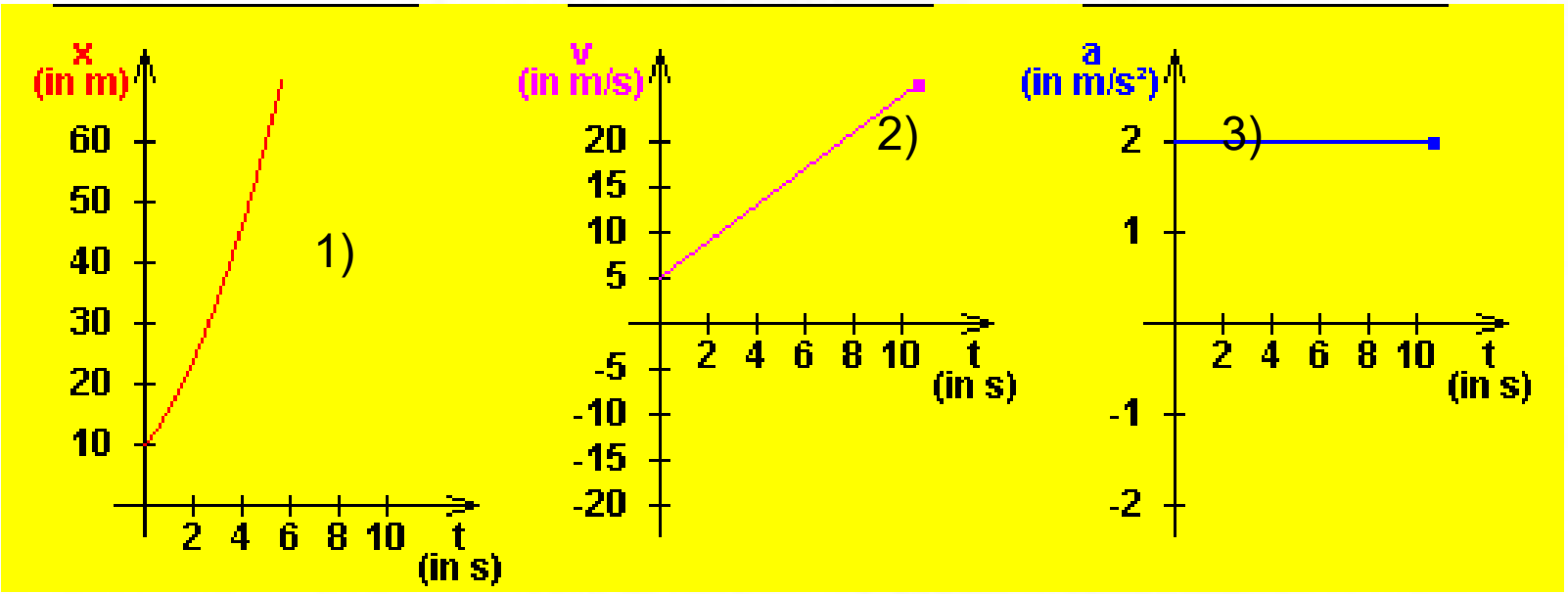
3) a = constant

The graph is a horizontal line. A is constant.









A) from graph 3) what is the acceleration a = _____.

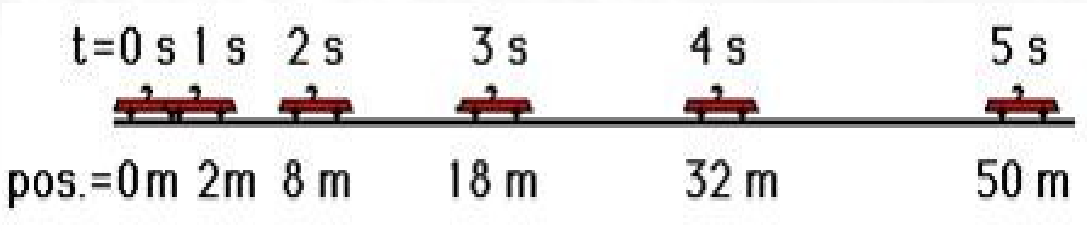
B) from graph 2) what is the initial velocity Vo = ___
What is the equation V(t) ? (use A) and Vo)
C) From graph 1) what is the initial position Xo
What is the equation of motion x(t) ?
D) fill the tables
E) copy and paste the table time (t) / position (x) in a spreadsheet.
Make a scatter plot. Fit a polynomial degree 2 (quadratic equation) and display equation
F) Copy and paste the table time(t)/ velocity(t) in a spreadsheet.
Make a scatter plot. Fit a line and display equations.

t	x
0	
1	
2	
3	
4	
5	
6	

t	V
0	
1	
2	
3	
4	
5	
6	

Exercise: consider the following object accelerating at a constant rate.

1) fill the tables
2) what is the acceleration of the object? (rate at which V increases – per second)
2) what is the initial position Xo ? The initial velocity Vo?
3) what are the equations of motion V(t) and X(t)?
4) use the tables to graph X(t) and V(t) (scatter plots)
5) fit the best fit line to V(t) . What is its equation ? So ?
What does the slope represent ?
6) fit a polynomial degree 2 to x(t). What is the equation ? So ?

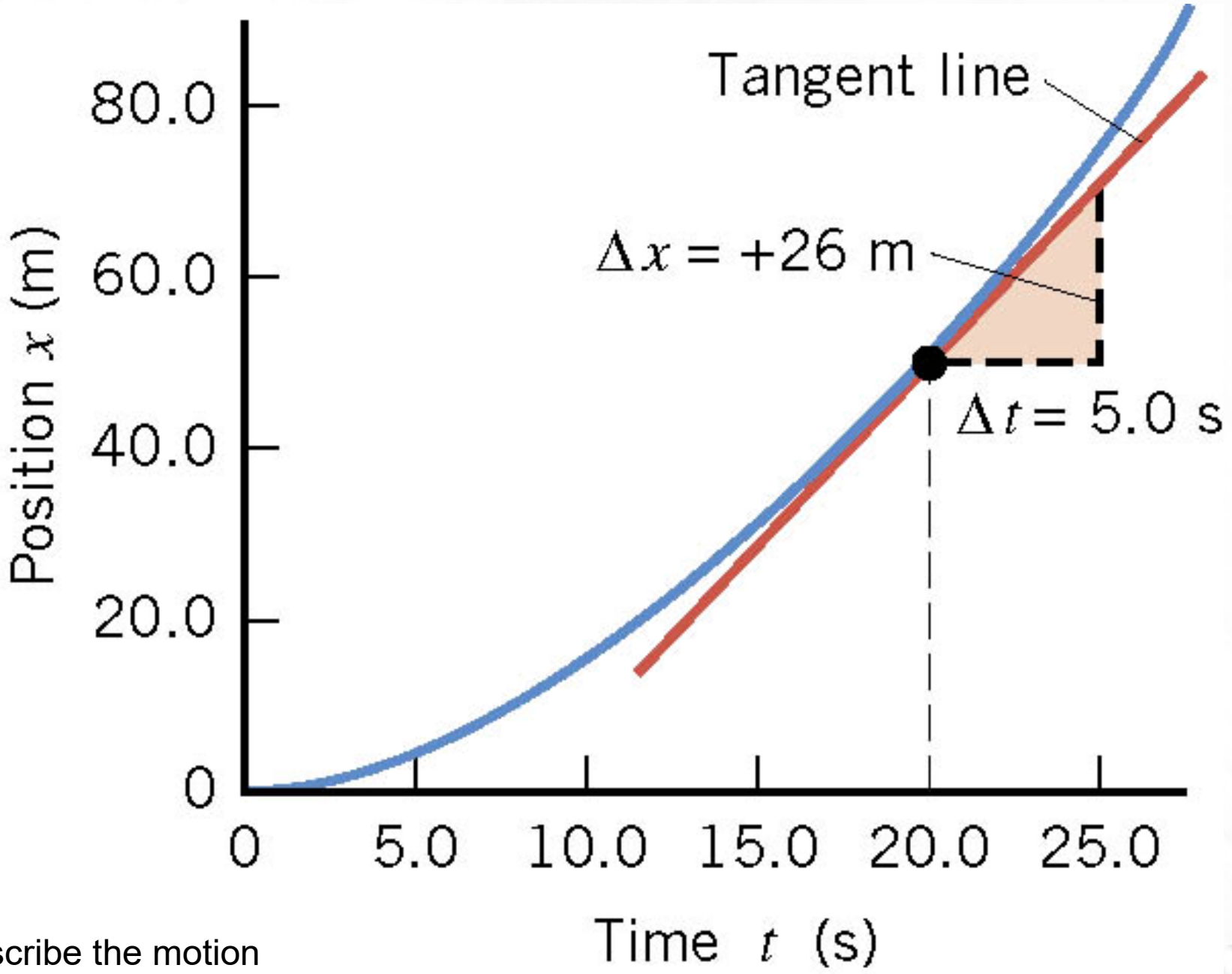


Vel= 0 4m/s 8m/s 12m/s 16m/s 20m/s

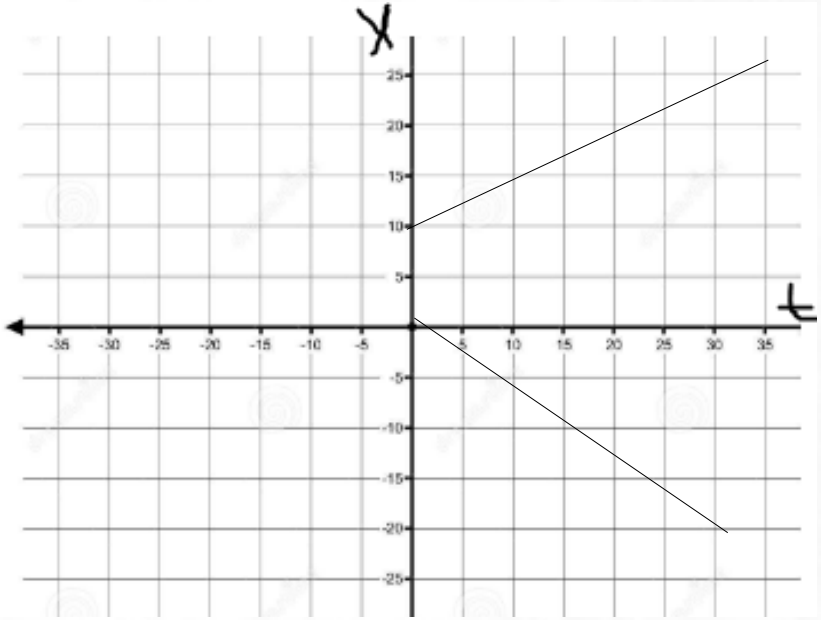
time	pos
0	0

time	vel
0	0

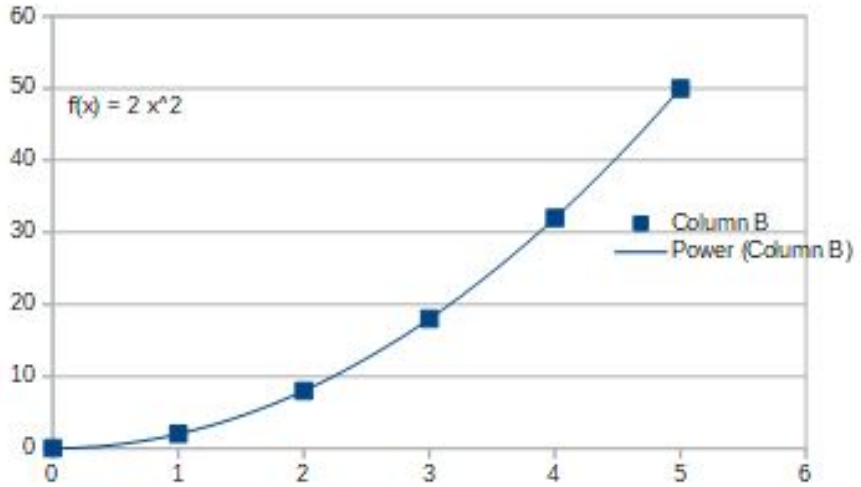
The slope of x(t) is the velocity V(t) at a given time t. It keeps increasing at a constant rate a.



Describe the motion
And find the instantaneous velocity



Equation of motion X(t)
And V(t) for 2 graphs

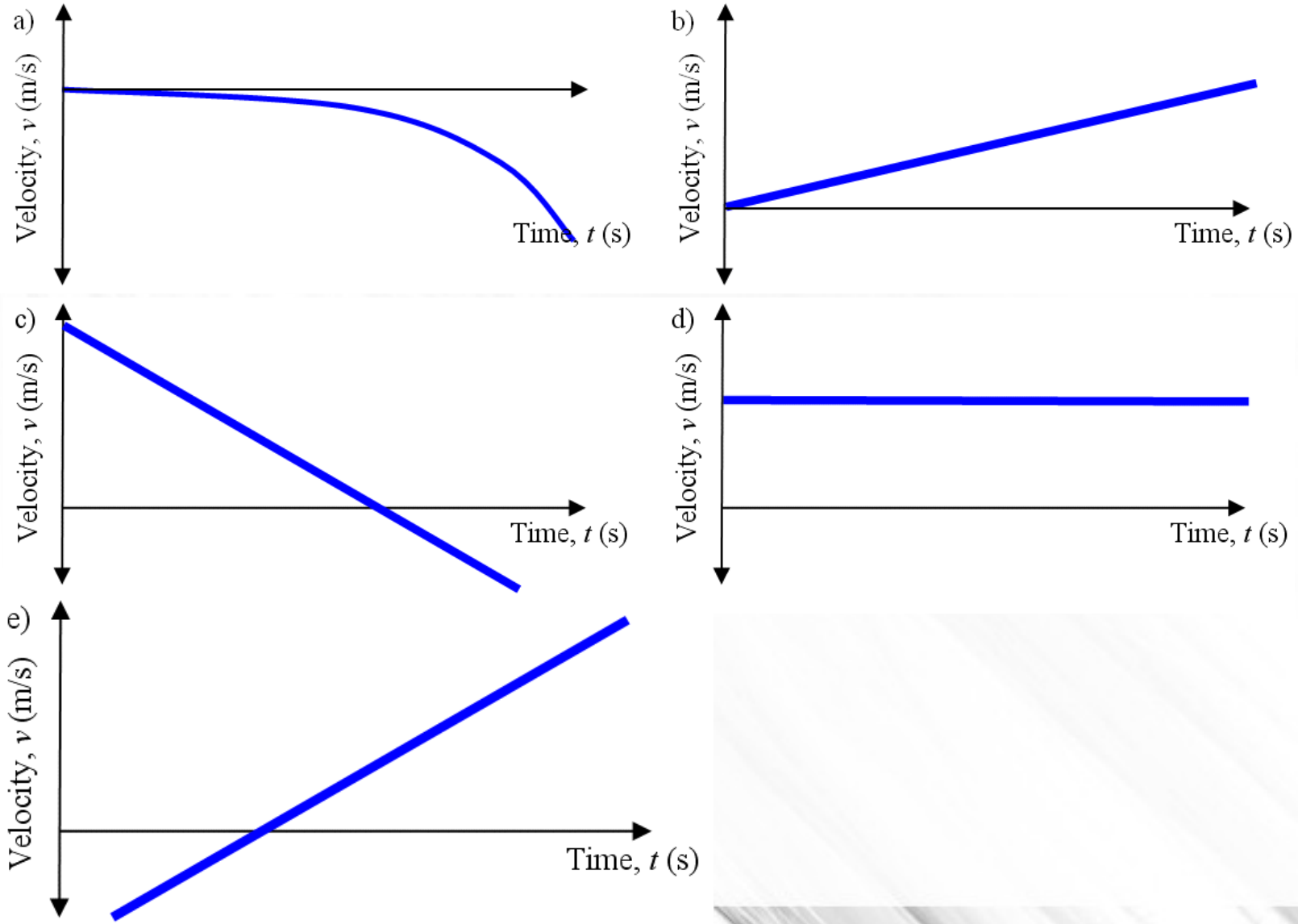


This is a graph position vs time
What is the average velocity between t=2 and t =5s ?

What is the position at t=3s?

Velocity is the slope of the graph
What is Vo ? (V at t=0 or slope At t=0)

. Which of the following velocity vs. time graphs represents an object with a negative constant acceleration?



. Which one of the following quantities can be determined from the slope of a position versus time graph for an object in motion?

a) position

b) velocity

c) acceleration

d) distance traveled

e) displacement

Which one of the following quantities can be determined from the slope of a velocity versus time graph for an object in motion?

a) position

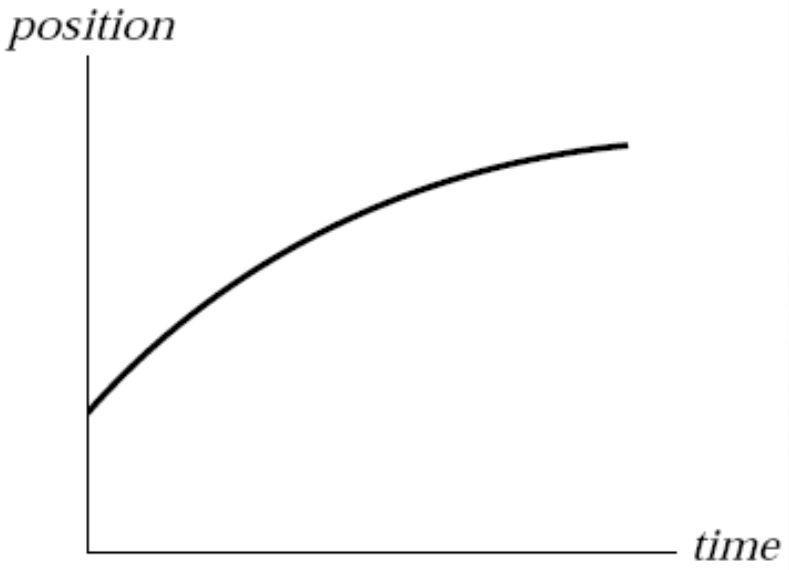
b) velocity

c) acceleration

d) distance traveled

e) displacement

A train car moves along a long straight track. The graph shows the position as a function of time for this train. The graph shows that the train:



1. speeds up
2. slows down all the time.
3. speeds up part of the time and slows down part of the time.
4. moves at a constant velocity.

Source slide: Eric Mazur, peer instruction, Pearson Education

Consider an object moving @ left (or down) and speeding up/

A) from graph 3) what is the acceleration ? a=_____. So There is a pull@ _____

B) from graph 2) what is the initial velocity ? Vo= _____ . Is the velocity negative or positive?

So the object is moving @ _____. What is the equation V(t) =

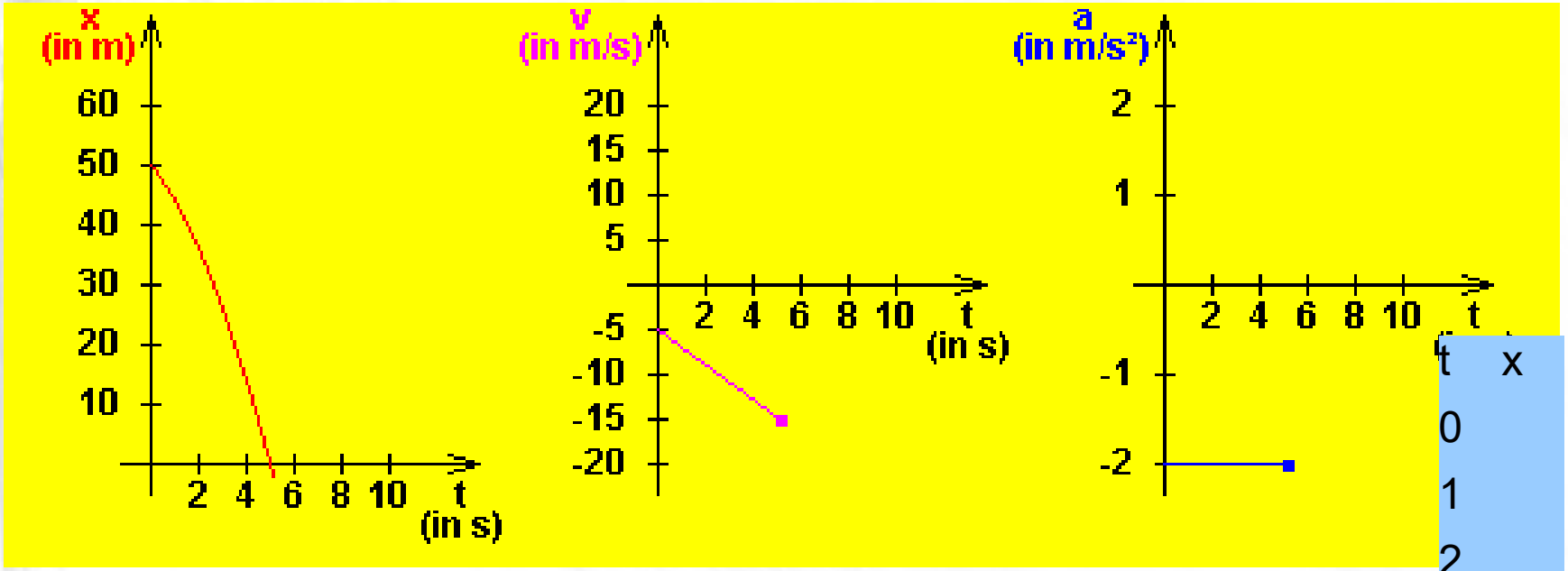
C) from graph 1) what is the initial position Xo.

What is the equation of motion ?

D) Fill the tables below (using the derived equation)

E) copy and paste the table time (t) / position (x) in a spreadsheet. Make a scatter plot. Fit a polynomial Degree 2 (quadratic equation) and display equation

F) Copy and paste the table time(t)/ velocity(t) in a spreadsheet. Make a scatter plot. Fit a line and display equations.

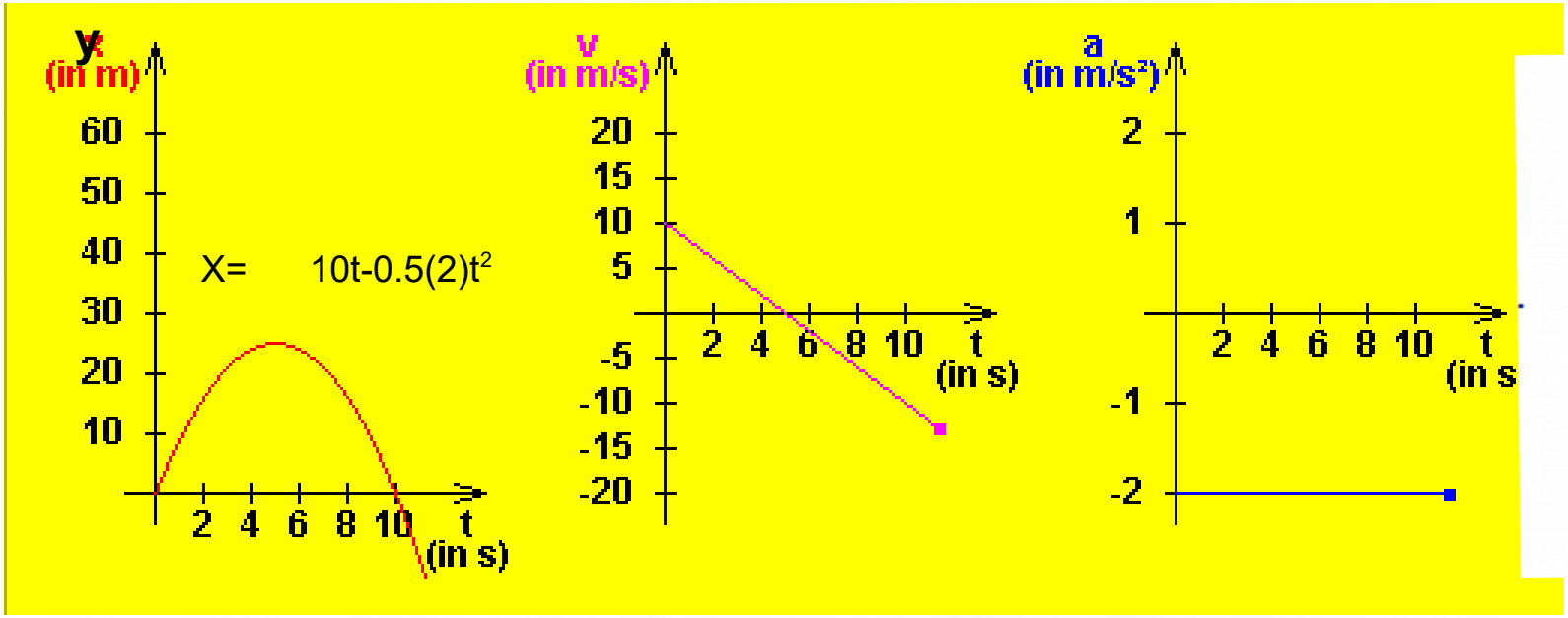


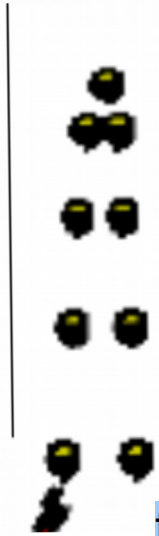
t	x
0	
1	
2	
3	
4	
5	

t	V
0	
1	
2	
3	
4	
5	
6	

To do: virtual lab assignment slowing down

Consider the motion of an object thrown in the air with an initial velocity Vo . It moves @ up but slows down, stops and changes direction and moves @ down but speeds up. y(t) is the position of the object.
(This is not happening on Earth. But on another viable planet)





t	V
0	
1	
2	
3	
4	
5	
6	
7	
8	

t	x
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

A) from graph 3) what is the acceleration ? a=_____. So There is a pull@ _____
B) from graph 2) what is the initial velocity ? Vo= _____ . Is the velocity negative or positive?
So the object is moving @ _____. What is the equation V(t) =
C) from graph 1) what is the initial position Xo.
What is the equation of motion ?
D) Fill the tables below (using the derived equation)
E) copy and paste the table time (t) / position (x) in a spreadsheet. Make a scatter plot.
Fit a polynomial degree 2 (quadratic equation) and display equation
F) Copy and paste the table time(t)/ velocity(t) in a spreadsheet.
Make a scatter plot. Fit a line and display equations.